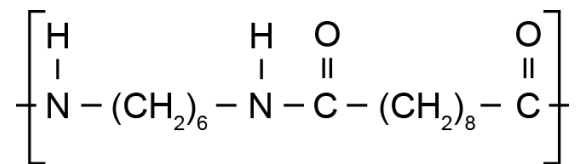


ANSWERS: Polymers

1. (i)



(ii) This is condensation or substitution (polymerisation), whereby the two monomers are joined together and a small molecule ($\text{HCl}(g)$) is released.

(iii) Each monomer is di-functional or has a reactive site at each end (allowing polymerisation to be ongoing.)

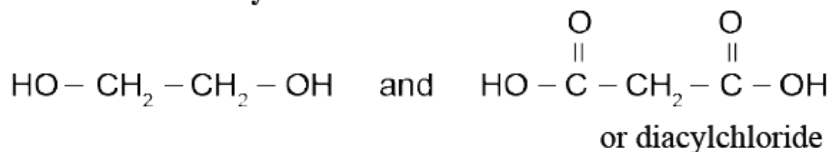
(iv) The sebacyl chloride (as an acyl chloride) reacts vigorously with water forming the carboxylic acid, (however, it does not react with the non-polar solvent.) Dilute acid will cause hydrolysis of the amide linkage. The products formed would be (di) ammonium salt or $^+\text{H}_3\text{N}(\text{CH}_2)_6\text{NH}_3^+$ and the (di) oic acid. $\text{HOOC}(\text{CH}_2)_8\text{COOH}$ (Names not required)

2.

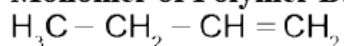
$\begin{array}{c} \text{CH}_3\text{CHCOOH} \\ \\ \text{NH}_2 \end{array}$	<p>Acid hydrolysis conditions: $\text{H}_2\text{O}/\text{H}^+$ or $\text{HCl}(aq)$ and heat or reflux</p> $\begin{array}{c} \text{CH}_3 \quad \text{O} \\ \quad \\ \text{H}_3\text{N}^+ - \text{CH} - \text{C} - \text{OH} \end{array}$	<p>Basic hydrolysis conditions: $\text{H}_2\text{O}/\text{OH}^-$ or $\text{NaOH}(aq)$ and heat or reflux</p> $\begin{array}{c} \text{CH}_3 \quad \text{O} \\ \quad \\ \text{H}_2\text{N} - \text{CH} - \text{C} - \text{ONa} \end{array}$
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3. a)

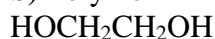
Monomers of Polymer A:



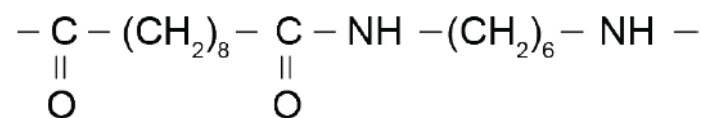
Monomer of Polymer B:



b) Polymer A



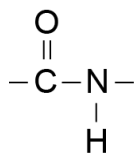
AND



c) • The diamine is water soluble because it is a polar molecule / forms hydrogen bonds with water / partially ionises.

• Sebacyl chloride (acid chloride) is dissolved in the non-polar solvent, as it reacts (vigorously) with water forming acidic solutions.

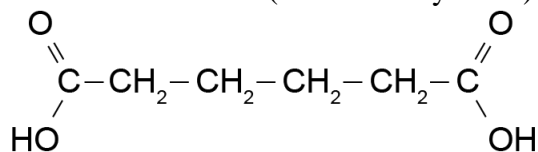
• NaHCO_3 is added to the solution to neutralise the HCl / neutralise the acid formed during the reaction / prevent the nylon from undergoing acid hydrolysis.



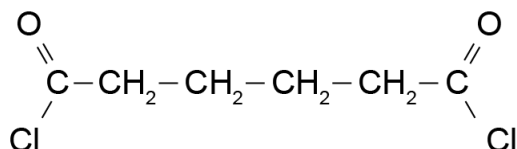
4. a)

One link is circled.

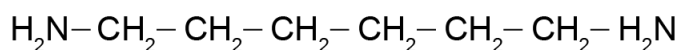
b) One set of monomers (can be in any order)



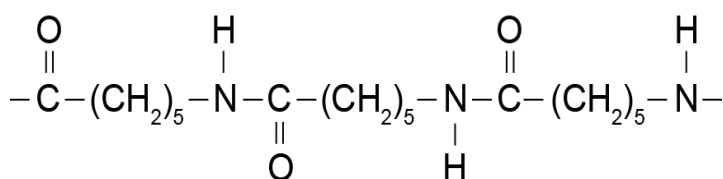
OR



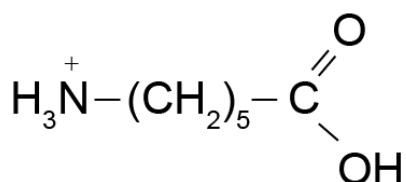
AND



c) i) 6-amino hexanoic acid

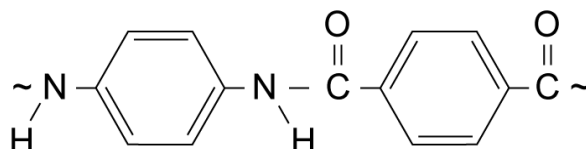


d) The acid would hydrolyse the rope. This would cause the amide linkages to break and form the monomers. The rope would lose strength.

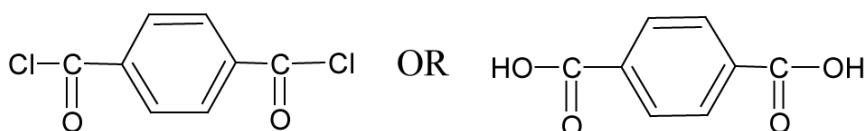
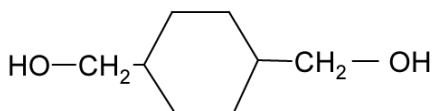


OR products from nylon 6,6.

5. The repeating group is:



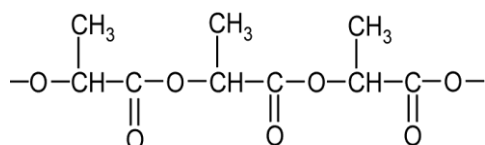
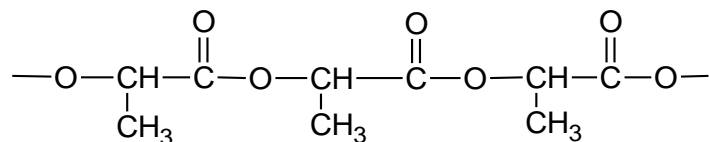
- The monomers have functional groups at both ends, so can react to form a long chain. (mention of diacid chloride, diacid, diamine sufficient).
 - The acid chloride and amine react to give an amide functional group or peptide bond.
 - The reaction is a condensation reaction, since a small molecule (HCl or H₂O) is released.
 - When the amine and the acid are used without heating, a proton transfer (acid-base reaction) occurs and hence polymerisation does not occur until the reaction is heated.
- The acid chloride is more reactive than the carboxylic acid.



6. a) i)

ii) A small molecule, such as H_2O or HCl , is eliminated when the monomers join.

b) Polymer (Compound X)



7.

8. a) i) Reagent 1 NaOH (KOH , OH^-)

Reagent 2 SOCl_2 , PCl_3 , PCl_5

Reagent 3 NH_3

ii) Compound P $\text{HOOC(CH}_2\text{)}_4\text{COOH}$

Compound Q HCl

iii) Repeating unit is an amide linkage, ie

$\text{---HN(CH}_2\text{)}_6\text{NHOC(CH}_2\text{)}_4\text{CO---}$ (*dimer acceptable*)

b) Nylon is easily hydrolysed with acidic solutions as the amide bonds are broken and so monomer molecules are reformed.



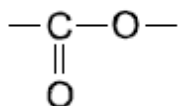
Monomer molecules acceptable (ie $\text{NH}_2(\text{CH}_2)_6\text{NH}_2$ and $\text{ClOC(CH}_2\text{)}_4\text{COCl}$).

Teflon is not hydrolysed as the chain involves a series of C---C single bonds that are not easily broken.

9. A **polymer** is a **long chain molecule** formed when **many molecules or units** (ie monomers) link together.

Polyester chains are formed by **condensation** with the loss of H_2O or HCl at each ester linkage.

Polyesters contain ester linkages.



A **single monomer** must be a hydroxy alkanolic acid or hydroxy alkanoyl chloride
eg



Two different monomers can be a diol and a dioic acid / a diol and a diolyl chloride / two different hydroxy alkanolic acids / two different hydroxy alkanoyl chlorides eg

